Now or Never? The Importance of Immediate Energy Use Feedback

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BECC, October 20, 2015
Imagine driving on a highway without a speedometer…

…and only receiving a message a couple of hours later...

…and that your household’s fleet of vehicles drove at an average speed of 45 mph this morning.

That’s roughly the status of what we call “smart metering” these days in the utility sector.
Today’s smart metering programs provide feedback on *aggregate* household electricity use - and generally on *past* behavior.

- How often are web portals and in-home displays really accessed in real time, while people cook, vacuum-clean, etc.?
Today’s feedback is generally delivered after the behavior has taken place: Individuals can only make resolutions for the future.

- Feedback on past behavior create general awareness and help individuals to derive strategies for future conservation behavior.
  - Like New Year’s resolutions…

- Can’t be do better than that with smart metering?

- Some agreement that feedback should be
  - Specific (yet how specific?)
  - Timely (yet how timely?)
  - Frequent (results inconclusive)

- Let’s do it!
We provide real-time feedback on a specific, energy-intensive behavior: showering.

**Why feedback on shower behavior?**

- Water heating: 2nd largest residential energy end use
- High degree of user control
- Few distractions
- With better insulated houses, the share of water heating will increase considerably
Why showering as a target behavior?

- Average shower lasts 4 minutes
- Requires 2.5 kWh of energy
- Enough to power 2,200 (!) CFLs (17 W) during the same time…
We use amphiro a1 smart shower meters to capture granular data on actual behavior and consumer response to different behavioral interventions.

The **standard amphiro a1 shower meter** displays / stores

- Water consumption
- Energy consumption
- Water temperature
- Energy efficiency class
- Polar bear animation

**Activated automatically** (“data push”)

- No battery – the device harvests energy from the water flow

**First randomized controlled trial with 697 households in Zurich in 2012**

- Survey data (socio-demographics, personality, environmental attitude…)
- Sample had also completed an electricity smart metering study
In our 2012 study, the smart shower meter reduced energy use by 22% - yielding a much larger conservation impact than electricity smart metering.

- **Average conservation effect of 22% (!)**
- **Also much larger absolute impact** than electricity smart metering study with the **same pool of households**

<table>
<thead>
<tr>
<th>Yearly reduction</th>
<th>Electricity smart metering study</th>
<th>Smart shower meter study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy – relative consumption change</td>
<td>3.2% of household electricity</td>
<td>22% of shower energy</td>
</tr>
<tr>
<td>Yearly energy savings</td>
<td>86 kWh</td>
<td>443 kWh</td>
</tr>
<tr>
<td>Yearly CO2 savings</td>
<td>9 kg (US electricity mix: 56 kg)</td>
<td>98 kg (US mix water heating: 190 kg)</td>
</tr>
<tr>
<td>Yearly water savings</td>
<td>/</td>
<td>2250 gallons</td>
</tr>
<tr>
<td>Yearly cost savings</td>
<td>$25</td>
<td>$140</td>
</tr>
</tbody>
</table>
The results opened up several questions for further research…

- **Key learning of our first study:**

  Real-time feedback on a specific behavior can yield a much larger impact than the provision of broader feedback.

- **Open questions:**
  - How essential is the immediacy of feedback?
  - To what extent can we transfer this to other behaviors? Or is showering just “different”?
  - Can we replicate the effect size elsewhere?
  - Role of goals, social norms,…
  - Can we replicate the large effect with other samples?

→ **New study** in 2015 in collaboration with Swiss Mobiliar Insurance (sustainability employee engagement program)
We have recruited 726 households all over Switzerland (employees of Mobiliar insurance and their families).

- 726 households recruited all over Switzerland (employees of Mobiliar insurance and their families)
  - Measurement data:
    - 641 households (89%)
    - 65’140 showers
  - Survey data
    - Socio-demographics, environmental attitude, personality traits, perception of the device,…

[Map of Switzerland showing the distribution of recruited households]
Our research design allows us to differentiate the impact of feedback *during* the behavior and feedback *right after* the behavior.

<table>
<thead>
<tr>
<th></th>
<th>Baseline (#1-10)</th>
<th>During shower (#11+)</th>
<th>After shower (#11+)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real-time group</td>
<td><img src="image1" alt="Image" /></td>
<td><img src="image2" alt="Image" /></td>
<td><img src="image3" alt="Image" /></td>
</tr>
<tr>
<td>Deferred feedback</td>
<td><img src="image4" alt="Image" /></td>
<td><img src="image5" alt="Image" /></td>
<td><img src="image6" alt="Image" /></td>
</tr>
<tr>
<td>Control group</td>
<td><img src="image7" alt="Image" /></td>
<td><img src="image8" alt="Image" /></td>
<td><img src="image9" alt="Image" /></td>
</tr>
</tbody>
</table>

Note: Still feedback on a *specific* action, given *almost* instantly
Randomization worked: The three groups use the same amount of energy per shower in the baseline period.
Control group households slightly increase their consumption.
Again, households in the real-time group reduce their energy use per shower by 22% (difference-in-differences analysis).
Sorry, the next two slides are not available online.
The effect of behavior-specific real-time feedback is immediate. In both studies, the effect was stable throughout the two-month study duration.

Other results on the impact of behavior-specific real-time feedback:

- Effects are **immediate** (full effect size in first shower with feedback)
- Effects are **stable** throughout the 2-month study
- **No impact** on shower **frequency**
  - Shorter showers are not compensated by more frequent showers
  - No undesirable side effects on cleanliness
- **High-users** reduce their energy consumption most
- Survey data to tweak out **behavioral mechanisms**…
Currently, we have five different amphiro studies with local partner organizations ongoing or completed.

- **Netherlands**, 600 devices
- **Switzerland**, 2 x 700 devices
- **South Korea**, 100 devices
- **Singapore**, 900 devices

Partner organizations:
Some impressions from the deployment in Singapore (900 devices)…
Thank you very much for your attention!

Questions?

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